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SUBSECTORAL ANALYSIS OF LABOUR PRODUCTIVITY IN INDIA*

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Introduction

1. The objective of this Seminar is to discuss concepts, measurement techniques and other aspects of labour productivity with a view to promoting the development of labour productivity statistics in the countries of Asia and the Pacific. Within this broad objective, this paper concentrates on subsector productivity analysis by scale of operation, region and industrial group. Accordingly, the objectives of the present paper are the following:

(a) To review various concepts and measurement techniques of labour productivity adopted at subsectoral level in Indian mining and manufacturing sectors;

(b) To measure subsectoral labour productivity by region and size in Indian mining and manufacturing sectors with a view to identifying major trends and problems;

(c) To examine the major causes behind the variations in labour productivity in Indian mining and manufacturing sectors;

(d) To identify and measure the likely contributions from labour productivity towards output from Indian mining and manufacturing sectors.

2. This paper is mainly based on the data available from secondary sources, periodically released by the statistical authorities. Occasional studies undertaken by organizations entrusted with the job of developing productivity statistics, such as the Central Statistical Organisation (CSO), the Labour Bureau, the National Productivity Council etc. have also been taken into account wherever possible and necessary. Further details regarding the methodology, viz., concepts and coverage, nature and sources of data, size of the units covered, industry classification, indices and their growth rates etc. are given in the relevant sections.

Concepts of labour productivity

3. Labour productivity can be defined in two ways: first, as the efficiency with which labour resources are utilized in the process of production; and secondly, as the contribution of labour resources towards output. While the emphasis in the former is on labour resources as a single factor input, in the latter it is on labour resources as one among a bundle of inputs, mainly along with capital.[1/] The former definition is amenable to easier quantification and measurement, compared with the latter.

/4.

1/ There are studies with more than two factor inputs. The additional inputs usually taken into account are technical progress, size and scale, skills etc., for instance.

4. Generally, efficiency of labour resource utilization has been measured by a simple ratio between labour inputs and total output. However, contribution of labour resources to output involves explicitly or implicitly production functions, the simplest form of which specifies an arithmetic combination of labour and capital inputs, the weights being the factor prices in the base year. There are other more refined production functions, such as the restricted Cobb-Douglas, the unrestricted Cobb-Douglas, the constant elasticity of substitution (CES-SMAC), the variable elasticity of substitution (VES) etc. In the present paper dealing with labour productivity measurement at subsectoral levels, attention is concentrated mainly on labour productivity as an efficiency level determinant, rather than on labour resource as a contributor to output. Accordingly, in this paper, labour productivity is defined as a simple ratio between labour and total output. An arithmetic index of total productivity is arrived at separately for the mining and manufacturing sectors, in order to have a better understanding of the trends in sectoral level productivity.

Coverage, nature and sources of data

5. The present paper covers all the industries included in the erstwhile census of manufacturing industries (CMI) and the current annual survey of industries (ASI) and the total mining sector. The study relates to the period 1951/52-1975/76. Later years could not be covered for want of detailed data from ASI sources.

6. The principal source of data on output in the manufacturing industries is ASI, which replaced CMI through which data were collected until 1958. ASI is designed to obtain comprehensive data on the functioning of the registered factory sector in India. The survey covers factories using power and employing 10 or more workers and is carried out under the statutory provisions of the Collection of Statistics Act (1953) in all the States and union territories of the India union except Jammu and Kashmir. In the case of Jammu and Kashmir, it is carried out under the provisions of the Jammu and Kashmir Collection of Statistics Act (1960). The primary unit of enumeration in the survey is a factory. In the case of the electric light and power industry, the unit is an undertaking by which is meant a State electricity board or a licensee under the Indian Electricity Act concerned with the supply of electricity.

7. For purposes of carrying out the survey, factories are divided into two categories, first, the census sector, covering all factories employing 50 or more workers and not using power, the second the sample sector consisting

/of

of all the remaining factories. Factories in the census sector are enumerated completely while those in the sample sector are enumerated on the basis of a 50 per cent probability sample. Electricity undertakings are included in the census sector irrespective of the number of workers employed.

8. The data used for the present paper relate to the entire factory sector and have been obtained by adding the census sector aggregates to the estimated totals of the sample sector. There are some differences in the quality of data over time because of variations in the coverage of the sectors. This is more so with respect to the years up to 1958, the data for which are based on the erstwhile CMI. However, the estimates up to the year 1958 were revised by the Central Statistical Organisation (SCO) and the output series for the period 1950/51-1958/59 made comparable with the post-1959/60 series. The output data used for the present study have been collected from the detailed national accounts (disaggregated) tables compiled by CSO.

9. The main source for labour data in the Indian manufacturing industries is also the CMI-ASI reports. "Workers" covered in this source are "persons employed directly or through agencies, whether for wages or not, in any manufacturing process or in cleaning any part of the machinery or premises used for a manufacturing process or any other kind of work incidental to or connected with the manufacturing process or the subject of manufacturing process". "Employees" cover all persons engaged by the factory in work connected directly or indirectly with the manufacturing process and include all administrative and clerical staff as also labour engaged in the production of capital assets for the factory's own use. This includes those employed in the sales and purchase departments also. Proprietors, partners and their unpaid family members who work in or outside the factory, persons in the head office connected with the manufacturing activity of the factory etc. are also included under this heading. The employment figures represent average daily employment. The measure of employment is based on attendance and not on the number of persons on roll. Thus, the average daily employment closely approximates the flow of labour input in the manufacturing process rather

than the stock of manpower available with the industries. The employment figures used here are taken from the consolidated results of the returns received under the Act and released periodically by the Labour Bureau.2/

10. The basic source of information on output relating to major minerals except coal, petroleum and natural gas is the data collected by the Indian Bureau of Mines under the Mineral Conservation and Development Rules (1958), framed under the Mines and Minerals (Regulations and Development) Act (1957). These rules cover all States of the Indian union and apply to all minerals except (a) petroleum and natural gas, (b) coal, (c) minor minerals and (d) any mineral declared as a prescribed substance for the purposes of the Atomic Energy Act (1962). The source of data for coal and lignite for all the States except Jammu and Kashmir is the Coal Controller's Office. The source for the coal and lignite statistics in respect of Jammu and Kashmir is the Jammu & Kashmir Minerals Ltd. Statistics of minor minerals have been gathered from the State governments.

11. The data thus collected are collated by CSO for the purpose of preparing the national accounts. The output data used in the present study have been taken from the detailed National Accounts (disaggregate) tables and a scheme of classification of mines has been adopted to accord simultaneously with the National Accounts tables and the sources of labour data used.

12. The principal source of data pertaining to labour in mines is the reports of the Director-General of Mines Safety, who is empowered to collect the required information under the statutory provisions of the Mines Act (1952). Until the year 1951, the information regarding labour in mines was collected under the Indian Mines Act (1923). The scope of the Act has changed slightly from time to time. The data thus collected relate to persons employed in mines and quarries except those specially exempted by the Central Government. The measure of employment used is the same as in the case of manufacturing sector, i.e., average daily employment.3/

/Classification

2/ Figures for years the 1951-1968 are from the statement on the trends in employment growth in the factory sector in India presented by the Reserve Bank of India, 1971. For the years after 1968, data are collected directly from various issues of the Labour Bureau's annual publication Indian Labour Statistics. Wherever necessary, employment data are re-grouped on the basis of the National Industrial Classification according to which CSO's National Accounts Statistics are published.

3/ The data utilized have been collected from CSO Statistical Abstract, various issues.

Classification of industries

13. Industries could not be grouped according to the International Standard Industrial Classification because Indian data are reported on the basis of the National Industrial Classification, as revised in 1970. The Labour Bureau follows a slightly different scheme of classification of industries for reporting the labour data. However, the Labour Bureau's data on employment could be re-grouped in accordance with the National Industrial Classification.

14. For reporting output data in respect of mines (in value terms) CSO has adopted a two-digit classification, i.e., major minerals and minor minerals. Major minerals are further divided into three groups, viz., coal and lignite, metallic minerals and non-metallic minerals. No further division has been made of coal and lignite. Metallic minerals have been subdivided into six groups: (a) iron ore, (b) manganese ore, (c) bauxite, (d) copper ore, (e) gold, (f) others. Non-metallic minerals have been subdivided into: (a) limestone, (b) mica, (c) others. Data on employment in mines, however, are not available according to the same classification. They are reported separately for (a) coal, (b) copper, (c) chromite, (d) diamond, (e) gold, (f) gypsum, (g) iron ore, (h) limestone, (i) magnesite, (j) manganese ore, (k) mica, (l) stone and (m) others.

15. The scheme of mines classification adopted here is in accordance with the availability of data for individual mine groups for both output and employment. Individual mine groups for which output and labour data are not available separately have been combined with the category "others'. Although coal has been retained separately for purposes of productivity analysis, there are some minor discrepancies between the coverage of output and labour in this case. While in the case of output the sector includes coal and lignite, in the case of labour it includes only coal. However, in view of the negligible share of lignite in the total employment and output of the coal sector, it is assumed that this discrepancy may not pose serious empirical problems.

Prices and price indices

16. Although there are price indices constructed for almost all products from Indian manufacturing and mining sectors,[4/] none of the direct deflating techniques could be adopted for the following reasons:

/(a)

4/ Index Number or Wholesale Prices in India released by the Economic Adviser (Ministry of Industry), Government of India, various issues.

(a) Values of output at current prices are available for all the industries only for the years 1960/61-1975/76;

(b) The classification of industries adopted by the Detailed National Accounts Statistics makes it difficult to choose an appropriate price index for each group of industries;

(c) The values of current inputs utilized by the industries have not been presented separately for the industry groups; instead values of inputs consumed have been presented only for the total manufacturing sector;

(d) Even the gross value added is available from the Detailed National Accounts Statistics for the total manufacturing sector only and not separately for the industry groups;

(e) The existing data on net value added by industry have been arrived at by deducting from the gross value of output a sum of gross value of current inputs and the value of fixed capital consumed. Therefore, the application of any one price index either for the output or for the inputs may not lead to reliable results.

17. The CSO net value added figures by industry are available at 1960/61 constant base year prices until the year 1970/71, and at 1970/71 constant base year prices for later years, including 1970/71 in the case of manufacturing sector. It is thus possible to inflate net value added figures by industry for the years up to 1969/70 by a constant factor derived from dividing the 1970/71 figures at 1970/71 prices by the 1970/71 figures at 1960/61 prices. This procedure has been adopted for each of the industry groups separately. In the case of the mining sector the same kind of exercise has been undertaken for the total mining sector as well as for individual mine groups, separately for gross and net value added.

Direct studies

18. Our objectives include an analysis of variations in labour productivity, in different size groups and in different regions. This has been achieved by considering the data contained in a recent study undertaken by the Industrial Statistics Division of the Central Statistical Organisation on wages and productivity in the organized manufacturing sector, 1960 to 1976. This study was based on the same source of data referred to above, i.e., ASI, and related to all industries taken together in manufacturing, electricity and gas, excluding water supply, sanitary services, recreational and personal services.

/Results

Results for each year were obtained separately for census and sample sectors and also for the combined factory sector. Beyond the classification into census and sample sectors, factories could not be arranged in any kind of size scale, based on data from ASI sources. The interregional analysis related to six States in the Indian union, viz., Bihar, Gujarat, Maharashtra, Tamil Nadu, Uttar Pradesh and West Bengal, contributing in all about 70 per cent of the total value added from the sector. The study arrived at value added at constant prices by deflating the time series at current prices with a calendar year average of the wholesale price index for all commodities with 1961/62 as the base year.[5/]

Growth rates

19. Growth rates of output, employment and productivity (base year 1970/71 = 100) have been computed for three periods 1951/52-1960/61, 1960/61-1975/76 and 1951/52-1975/76[6/] on the basis of a semi-log equation with the log of the growth phenomena being the dependent variable and years being the independent variable implying the compound rate of growth variants (see table 1-3 and table 6). However, tables 4-5 present only simple average rates of growth.

Growth rates of output

20. The net value added at 1970/71 prices was characterized by an increasing trend in the case of all the industries during the period 1951/52-1975/76. Despite the impressive growth recorded by a few industries such as paper and paper products, including printing, furniture and fixtures, rubber and rubber products, including products for petroleum and coal, chemical and chemical products, non-metallic mineral products, basic metal

/industries,

5/ The index number of the wholesale prices of all commodities has a sizable weightage for products originating in sectors other than manufacturing. In view of this, the index number of wholesale prices of manufacturing would have been more appropriate than the one used by CSO.

6/ The series was truncated at 1959/60 for a variety of ressons. The year 1960/61 marked the beginning of the second decade of planned economic growth, the adoption of a capital-intensive, heavy industry-based growth strategy and import substitution-based trade strategy being the prominent feature of this decade.

industries, metal products except electrical machinery and transport equipment, machinery except electrical machinery, electricity, gas and water supply and miscellaneous industries, the net value added of the total manufacturing sector increased only at a moderate rate because of the low rates of growth of a few industries, the shares of which were very high in the total output of the sector. The case of industries like textiles, food, beverages and tobacco and transport equipment could be cited as relevant in this context.

21. In the case of a majority of industries, there was a deceleration in the growth of output during the 1960s and 1970s when compared with that in the 1950s. This temporal pattern was applicable to almost all industries including the traditional ones like textiles, food, beverages and tobacco etc. In fact, in the case of leather and leather products, including footwear and transport equipment, net value added had actually declined, the rates of decline being as high as 3.05 per cent per annum in the case of the former during the period 1960/61-1975/76.

22. Of the eight mine groups for which data were available separately, gross value of production from manganese ore, gold and mica declined during the period under review. The rates of decline in the case of gold and mica were fairly high. While the rates of growth of gross value of production were comparatively high in the case of iron ore, limestone and other minor mines, in the case of coal and lignite and copper they were only modest. The comparatively low rates of growth of output of the total mining sector, even when a majority of mines such as iron ore, limestone and other minor mines recorded impressive growth rates, could be attributed to the low growth of coal and lignite which constituted a major share in the total output and partly by the decline recorded by the output from traditional mines such as manganese ore, gold and mica.

Growth rates of employment

23. All but one of the industries recorded positive rates of growth of employment during the period 1951/52-1975/76. The rates of growth of employment were fairly impressive in the case of such industries as electrical machinery, machinery except electrical machinery, basic metal industries, metal products except machinery and transport equipment, chemicals and chemical products, rubber and rubber products, including

/products

products for petroleum and coal etc. Moderate rates of growth of employment were recorded by such industries as food, leather and leather products, including footwear, wood and wood products, including furniture and fixtures, paper and paper products, including printing and publishing, non-metallic mineral products etc. To a large extent the depressed rate of growth of employment in the total manufacturing sector could be explained by the stagnating employment in the single largest industry, viz. textiles and tobacco and partly by the declining employment in transport equipment. The growth rates of employment were higher during the period ending 1959/60 when compared with those during the years after 1960/61. In fact, employment declined in a few traditional industries such as textiles and transport equipment during the later period.

24. The rate of growth of employment in the Indian mining sector came only to a negligible order of 0.38 per cent per annum during the period 1951/52-1975/76. Although mine groups such as iron ore, copper, limestone and other minor mines recorded considerably higher rates of growth, this by itself did not result in a substantial increase in the employment in the total mining sector partly because of the low rate of growth of employment recorded by the largest single mine group, viz. coal and lignite, and partly because of the negative rates of growth of employment recorded by mine groups such as manganese ore, gold and mica.

25. As in the case of the manufacturing sector, the rate of growth of employment in the total mining sector was considerably lower during the period 1960/61-1975/76. In fact, employment declined in a majority of mine groups during the later period. Employment decreases occurred in such important mine groups as iron ore, manganese ore, gold, limestone and mica. Increases in employment occurred only in the case of coal and lignite, copper and other minor mines during this period.

Growth rates of productivity

26. Net value added per employee in the total manufacturing sector increased at an annual rate of growth of 1.34 per cent per annum during the period 1951/52-1975/76. Gross value added at 1970/71 prices per employee increased at the rate of 1.44 per cent per annum during the same period. The highest rate of productivity growth occurred in miscellaneous industries

/followed

followed by machinery except electrical machinery, electricity, gas and water supply and beverages and tobacco. Industries such as wood and wood products, including furniture and fixtures, paper and paper products, including printing and publishing, chemical and chemical products, transport equipment etc. recorded positive growth rates in productivity but below the sectoral average. Others such as food, textiles, basic metal industries etc. recorded comparatively unimpressive rates of growth in productivity. Productivity in two industries, viz. leather and leather products, including footwear, and metal products except machinery and transport equipment actually declined during the period. The temporal pattern of productivity seemed to have followed those of output measures and employment, i.e., the period 1951/51-1958/59 recording higher rates of growth in productivity when compared with those during the period 1960/61-1975/76.

27. In the case of the mining sector gross value of production per employee increased at a rate of 1.92 per cent per annum during the period 1951/52-1975/76. Gross value added per employee recorded a somewhat higher rate of growth during the same period. While growth of productivity was highest in the case of other minor mines, iron ore came second, manganese ore third with regard to gross value of production during 1950/51-1975/76. While the productivity declined in the case of gold during the same period, modest growth rates were recorded by limestone and coal and lignite.

28. Unlike the case of manufacturing industries, the period 1960/61-1975/76 witnessed a somewhat higher growth of productivity in the mining sector when compared with that during 1951/52-1959/60. In the mining sector, the gross value of output per employee which had increased at a rate of 0.85 per cent per annum during the period 1951/52-1959/60, increased at a rate of 1.71 per cent per annum during 1960/61-1975/76. Although with varying degree, the same pattern was discernible even when output measures were changed to gross value added and net value added.

Analysis by size

29. Analysis of productivity growth by size has had to be limited to the case of the manufacturing sector because of non-availability of adequately representative data in the case of the mining sector. The total factory sector was divided into census and sample sectors by the data source itself. The sample sector consisted of factories employing 10-49 workers and using power and those employing 20-99 workers but not using power. The census sector

/consisted

consisted of all factories employing 50 or more workers using power and those employing 100 or more w thout using power. In the absence of any other break-down of manufacturing units by size, this analysis has had to be limited to these two size groups. The study undertaken by the Industrial Statistics Division of CSO, from which results were drawn for the present paper, also limited the scope of its enquiry to post-1960 years. Since the ISD-CSO study did not provide any subsectoral data, this paper has had to be limited in scope to the total factory sector only.

30. The relevant data are presented in table 4. All indices were characterized by lower average rates of growth in the case of the sample sector (representing the small sector) when compared with the census sector (representing the large sector). In fact, gross value added per employee at 1961/62 prices virtually remained constant in the sample sector during the period 1960-1976. Further, while productivity increased at an average rate of 2.0 per cent in the census sector, in the total factory sector it increased only at a rate of 1.8 per cent, as the productivity declined in the sample sector, although the rate of decline was negligible. As against these trends in productivity, emoluments per employee at 1961 consumer prices increased at a rate of 1.6 per cent in the census sector, while in the sample sector, the same increased at a nominal rate of 0.7 per cent.

31. A crucial limitation of this analysis is the extremely limited classification of the factories as implied in the definition of the sample and census sectors. Unfortunately, the data are not amenable to any further treatment. In particular, it would have been desirable to categorize the factories into various size scales, say below 100, 100-500, 501-1,000, 1,001-2,000, 2,001-5,000, 5,001 and above employees, in which case the pattern could have been subjected to a detailed scrutiny. This, however, has not been possible because data were not available.

Regional variations

32. Regional variations in productivity growth were based on the ISD-CSO study already mentioned. Six Indian States, together accounting for about 70 per cent of the total value added were covered by the ISD-CSO study. These were the States of Bihar, Gujarat, Maharashtra, Tamil Nadu, Uttar Pradesh and West Bengal.

33. Selected indicators of the census and sample sectors from these States are presented in table 5. Value added per employee increased in all States in the case of the census sector. In the case of the sample sector, however, the ratio increased only in the case of only one State, Maharashtra.

/Causes

Causes of labour productivity increases

34. Productivity defined as a technological relationship between inputs and output implies the existence of a production function. It is important to differentiate between the movement along the same production function and shifts in the production function. An observed increase in labour productivity could have its origin in either of the two. It is the distinction between the two processes and the causes therein which are of fundamental significance in matters relating to policy formulation. It is crucial to ascertain whether the increased labour productivity is the result of an increase in the efficiency with which the total input is utilized or is merely the consequence of higher automation. To the extent that the former is the case, an upward shift in the production function might have occurred and consequently the total productivity could also have increased. However, if automation is the cause, labour productivity could increase only at the cost of other associated inputs, notably capital, in which case the total productivity need not simultaneously increase.

35. Evidence presented by some earlier studies tends to lead to the conclusion that the total factor productivity in a majority of Indian industries was either stagnant or declining. For instance, the total productivity series computed for the period between 1946 and 1957 did not show any definite upward trend. Between the years 1951 and 1963, percentage rise or fall in both total input and output were almost of the same order. Productivity of all inputs taken together did not show any appreciable rise even though labour productivity rose significantly. A later study also showed that total productivity declined steadily over the period 1946-1964 and that most of the gains in labour productivity were due to capital deepening. While comparing the performance of the Indian economy with that of Japan, Ranis and Fei underlined the tendency towards capital deepening in Indian manufacturing industries.1/ Most of the increases in labour productivity, according to these studies, were traced to increasing capital intensity. On the basis of three alternative types of total factor productivity indices, viz. the Solow index, the Kendrick index and the CES index, later studies also concluded that between 1946 and 1964 while the labour productivity had increased at a trend rate of 3.3 per cent per annum,

/total factor

1/ G. Ranis and J.C.H. Fei, "Capital accomulation and economic development", American Economic Review, 1963.

total factor productivity showed a trend rate of decline of 1.6 per cent per annum. The above findings were corroborated by three studies of industries undertaken by the National Productivity Council. These studies also found acceptable evidence in favour of the hypothesis that labour productivity increased in the Indian industries because of the increased capital deepening.

36. To some extent the above conclusion was reinforced by the difference in labour productivity growth by industry presented in the earlier section themselves. It should be recalled that, in general, higher productivity growth was recorded only by modern industries. Labour productivity was either stagnating or declining in traditional industries. Most of these modern industries commenced production during the post second five-year plan period and employed techniques of production which were highly capital-intensive. For obvious reasons, in these industries labour productivity was not only high in comparision with traditional industries in any year but its rates of growth were also high.

37. The hypothesis of "capital deepening" leading to labour productivity increases also seemed to have been substantiated by the differences in the growth rates of productivity measured by the alternative output indices, namely net value added and gross value added. While net value added per employee increased at an annual rate of 1.34 per cent, gross value added per employee increased at a rate of 1.44 per cent, implying the share of capital consumption in gross value of production increasing over time. This difference worked out to be significantly large in the case of the mining sector, indicating the fact that the rate of capital deepening was much higher in the mining sector than in the manufacturing sector.

Capital and total productivity

38. With the background of the overwhelming evidence of increasing capital deepening in the case of the Indian manufacturing sector, trends in capital and total productivity have also been examined. However, these efforts have been constrained by the absence of a consistent time series of capital input in the mining and manufacturing sectors. These are two sources of data regarding capital input in the Indian economy: (a) broad data by sector on capital formation in the Indian economy from the Detailed National Accounts Statistics, and (b) the detailed data by industry on capital employed available from CMI-ASI. The estimates from the former source are based on the expenditure and commodity flow methods of measuring capital formation. Obviously for measuring productivity the data from the former source would be grossly inadequate. The latter have also been found to be inadequate because:

/(a) Such

(a) Such data are available in the case of the manufacturing sector, but corresponding figures are not available in the case of mining sector;

(b) CMI-ASI data on capital employed are available only at current prices. As the present exercise requires data at constant base year prices of 1970/71, reliance on this source inevitably involves empirical difficulties. Index numbers of wholesale prices of machinery and equipment are, of course, available but at highly aggregated levels. Data arrived at on the basis of aggregated price indices may be unreliable because of the mere aggregation errors they may contain.

39. In the absence of direct data regarding the volume of capital input employed by these sectors from any of the readily available sources, there is perhaps no alternative to an indirect index of capital input. The method used for arriving at an index of capital input in the present paper is based on deriving data on capital employed from data on capital consumption. This involves the assumption of a fixed relationship (invariant over time) between the capital consumption during any year and the capital employed during that year. Suppose that the value of fixed capital employed during the base year is K_o, then capital consumption C_o during the same year may be given by the expression:

$$C_o = d_o k_o \qquad (1)$$

where d_o is the rate of depreciation of fixed stock "k_o"

Similarly $$C_t = d_t k_t \qquad (2)$$

where the subscript "t" represents comparative year "t"

If $$d_o = d_t = d_* \qquad (3)$$

the index of fixed capital sotck k_t/k_o would be the same as the index of capital consumption

$$k_t/k_o = C_t/C_o \qquad (4)$$

This implies that if we have the annual data on capital consumption, they can be used as an index of fixed capital input as well. The crucial issues to be solved in this context are:

(a) Whether there could be variations over time in the rate of capital consumption d_*;

(b) Whether the index of fixed capital stock k_t/k_o could be equated to the index of total capital stock K_t/K_o.

/40.

40. The disaggregated National Accounts Statistics, which provide a capital consumption index, estimate the capital consumption more or less on the concept of depreciation allowance made in the annual statements of accounts of manufacturing undertakings, using the data from CMI-ASI. These depreciation allowances are based on the cost of installation and the expected working life of the fixed assets, depending on the nature of the asset. However, while the working life of various kinds of assets installed in different industries at different points of time may vary, the working life of a notional unit asset of the total sector may well be assumed to remain constant, particularly for a short span of 25 years considered by the paper. In any case, because of the absence of detailed data regarding the technical and economic aspects of the assets employed by these industries, the above assumption may be unavoidable.

41. An issue altogether different from the one discussed above has surfaced when equating the index of the estimated stock of fixed capital with the index of total capital actually employed by these sectors. The difficulty is posed by the working capital component of the total stock of capital employed (K-k). Although data regarding working capital employed are available from ASI sources, those figures at current prices cannot be meaningfully converted into constant price terms. It has, therefore, been decided to use the index of fixed capital instead of the index of total capital in the present study. The empirical loss implied in such a method could be treated as minimal because of the fact that, in most cases, the volume of working capital employed would, more or less, be a fixed proportion of the fixed capital employed. In addition, because of the fact that the present paper requires only an index of capital input rather than the volume of capital input itself for any particular year, the distortions in the estimates from the above assumption may be treated as insignificant.

42. Depreciation allowances in the annual statements of accounts of working units would always be at current prices. These would have to be converted into 1970/71 base prices before arriving at the index of capital input. Data on capital consumption at current prices are not available from the Detailed National Accounts Statistics for the period prior to 1960/61; instead estimates of capital consumption are available at 1960/61 base prices, for the period 1951/52 to 1970/71, and at 1970/71 base prices for the period 1970/71 to 1975/76.

/43.

43. In the conversion of the series of capital consumption at 1960/61 base prices to the 1970/71 prices the method employed in the case of output measures discussed in the earlier sections in detail, has been adopted, i.e., multiplying the series at 1960/61 base prices by a constant factor derived from dividing the 1970/71 capital consumption figures at 1970/71 base prices by the 1970/71 capital consumption figure at 1960/61 base prices. The procedure has facilitated comparison of the capital input data with the data on output.

Total input and total productivity

44. Total productivity has been defined as a simple ratio between the output and a composite input, arrived at by an arithmetic combination of the inputs, labour and capital, weighted by the respective factor prices in the base year.8/

45. The index of total input (1970/71 = 100) has been arrived at as a weighted combination of the indices of labour and capital. In order to arrive at the weightage for an arithmetic combination of the indices of labour and capital, the base year net value added is allocated between labour and capital on the basis of their respective shares. The share of labour during the base year is arrived at by multiplying the emoluments per employee in 1970/71 in the manufacturing sector by the total of employees in the same sector during that year. The share of capital during the base year is given by the net value added minus the share of labour. Since no single uniform wage rate per employee is available in the case of the mining sector from any of the available sources of data, the emoluments per employee arrived at in the case of manufacturing sector, viz. Rs. 3,210, have been used to multiply the total number of employees in the total mining sector during the base year 1970/71 in order to arrive at the total wage bill. The remainder of the net value added (1970/71) of the mining sector is attributed to capital.

/46.

8/ Admittedly, this method of total productivity measurement implies the rigid assumptions of a perfectly competitive market, elasticity of substitution between labour and capital being infinite, equating the marginal products of individual inputs with their respective average factor prices etc. The validity of these assumptions may be a subject of serious debate. Yet we may have to accept that some of these assumptions would be retained in any other index to total productivity like the Solow index, the CES index, the VES index etc., although the list and the severity of the assumptions could be considerably reduced. We choose this index of total productivity simply because of its ease of manipulation and interpretation.

46. The indices of capital input, total input and total productivity thus arrived at are presented in the annex. The results shown in table 6 indicate that the hypothesis of capital deepening in these sectors cannot be rejected. The slow rate of growth of the index of output in comparison with that in the case of capital input has led to a fall in the index of capital productivity. The rate of decline in capital productivity is much steeper in the case of manufacturing sector than in the case of the mining sector. Total productivity shows a small increase in the case of the mining sector until 1972/73 and thereafter a short decline. Total productivity has risen in both the sectors, although the rate of increase may be treated as negligible in the case of manufacturing sector.

Contribution from productivity to output growth

47. The share of productivity in the increased output between any two periods has been arrived at on the basis of the following two identities.

Define:

$$V_o = L_o \left(\sum_i P_{io} q_{io} c_{io}\right) \qquad (1)$$

$$V_t = L_t \left(\sum_i P_{io} q_{it} c_{it}\right) \qquad (2)$$

where V = aggregate value of output (at constant prices)

L = aggregate number of persons employed

P_i = unit price of the output of the i^{th} industry

q_i = quantity of output of the i^{th} industry per labour employed in that industry

c_i = share of the i^{th} industry in aggregate employment

Subscripts "o" and "t" refer to the base and comparative years respectively. Now, the increase in output between the base year 0 and comparative year "t" would be given by:

$$V_t - V_o = L_t \left(\sum_i P_{io} q_{it} c_{it}\right) - L_o \left(\sum_i P_{io} q_{io} c_{io}\right) \qquad (3)$$

By simplifying and rearranging expression (3) we get

$$V_t - V_o = (L_t - L_o) \left(\sum_i P_{io} q_{io} c_{io}\right) \qquad (I)$$

$$+ L_t \sum_i P_{io} C_{io} (q_{it} - q_{io}) \qquad (II)$$

/+ L_t

$$+ L_t \sum_i P_{io} q_{io} (C_{it} - C_{io}) \qquad \text{(III)}$$

$$+ L_t \sum_i P_{io} (q_{it} - q_{io}) (C_{it} - C_{io}) \qquad \text{(IV)}$$

Component (I) above stands for the increment in output due to increment in employment alone, i.e., the increment in output ($V_t - V_o$) from the additional employment ($L_t - L_o$) had the output labour relation V/L remained constant at the base year level. Component (II), however, is the effect of productivity change on output, with the composition of employment between industries being unchanged. Component (III) stands for the output due to changes in the composition of employment during the period between the base and comparative years, productivity remaining unchanged during the period. Component (IV) emerges as a result of the effects of interaction among components (I), (II) and (III).

48. These four components have been derived in the case of both the mining and manufacturing sectors and are presented in table 7. The results show that:

(a) In the case of both mining and manufacturing sectors, productivity increase accounted for a major share of output growth during the period 1951-1975, the shares being about 60 per cent in the case of the mining sector and 57 per cent in the case of the manufacturing sector.

(b) The share of employment growth in the additional output of the mining sector between 1951 and 1975 was only about 16 per cent. However, in the case of the manufacturing sector, employment growth accounted for about 36 per cent of the additional output during the same period.

(c) In both the mining and manufacturing sectors, changes in the composition of employment accounted for an insignificant share of output growth during the period 1951-1975, which was about 3 per cent.

(d) While the interaction accounted for 21 per cent of the additional output in the case of mining sector, it accounted for only about 4 per cent of the additional output in the case of the manufacturing sector.

(e) Employment accounted for a little over three-quarters of the increased output during 1951-1956 and 1971-1975 in the case of the mining sector. The most interesting results were those relating to the

/periods

periods 1956-1961 and 1961 1966, the periods of the second and third five-year plans. While employment contributed only to the extent of 10-15 per cent of the additional output during this period, increases in productivity appeared to be by far the only major source of output growth in the mining sector accounting for about 61 to 75 per cent. Although the variations in composition of employment contributed as high a share of about 19 per cent during the second plan period, its share declined to about 8 per cent during the third plan period.

(f) Contributions from employment to the additional output turned out to be positive throughout the period 1951-1975 in the case of the manufacturing sector; 38 per cent during 1951-1956 and 94 per cent during 1971-1975. The share of productivity changes reached an all-time peak of 121 per cent in 1966-1971.

Summing up

49. Normally as the economy modernizes, the growth process becomes capital-intensive. Employment then increases at rates lower than either output or capital stock. Such capital deepening can take place through either or both of the following processes:

(a) A change in the output mix of the economy, towards modern capital-intensive subsectors like heavy engineering, petro-chemicals etc. This can take place either in the setting up of the new manufacturing units or in the diversification and expansion of the existing units.

(b) Modernization and rationalization of the existing traditional subsectors involving the introduction of capital-intensive processes.

In the context of the Indian mining and manufacturing subsectors, both the above processes appear to be relevant. For instance, output growth was the highest in subsectors whose relative capital intensity was high. The late 1950s and 1960s witnessed not only an expansion of the mining sector towards minerals, which employed more capital-intensive techniques and processes such as copper, zinc, iron ore, etc., but even the labour-intensive mines such as coal underwent some modernization and rationalization, both leading to capital intensification of the sectors. The process of capital deepening was more evident in those subsectors where the rate of expansion was the highest, such as non-electrical machinery (mostly items from the heavy engineering sector), rubber and rubber products including products from petroleum and coal, electrical machinery, chemical and chemical products, electricity, gas, water supply etc. Labour-intensive sectors like textiles,

/beverages

beverages and tobacco, food and food products, leather and leather products etc. were either stagnant or expanding at negligible rates, or even declining in some cases.

50. These being the general trends the world over, at least in the case of major industrialized nations, the Indian situation need not be considered at variance. However, the observed trends need careful study to the extent that the Indian economy is characterized by relatively abundant supplies of labour and therefore the labour productivity increases through large-scale substitution of capital for labour need not simultaneously ensure the maximum utilization of the total inputs. Herein comes the limitation of labour productivity indices as a measure of input utilization efficiency, particularly across countries with widely differing natural resources endowments. Labour productivity measures may be a useful guide only if the productivity ratios of all other major factors are also simultaneously considered.

/Table 1

Table 1. Growth rates of indices of output in the manufacturing and mining sectors (at 1970/71 prices)

(Per cent per annum)

	1951/52 to 1959/60	1960/61 to 1975/76	1951/52 to 1975/76
MANUFACTURING SECTOR	Net value added (at 1970/71 prices)		
Food	2.38*	1.00*	1.60*
Beverages and tobacco	5.05*	1.14*	2.27*
Textiles	1.28*	0.63	0.78*
Leather and leather products, including footwear	1.76	(-)3.05*	0.37
Wood and wood products, including furniture and fixtures	5.73*	1.03	3.39*
Paper and paper products, including printing and publishing	3.29*	1.82*	2.67*
Rubber and rubber products, including products for petroleum and coal	7.02*	3.04*	4.24*
Chemical and chemical products	3.35*	3.39*	3.79*
Non-metallic mineral products	4.75*	1.99*	3.11*
Basic metal industries	2.77*	2.08*	3.52*
Metal products except machinery and transport equipment	3.54*	0.51*	2.14*
Machinery except electrical machinery	8.29*	4.22*	6.55*
Electrical machinery	7.05*	5.04*	5.95*
Transport equipment	6.02*	(-)0.19	1.99*
Miscellaneous industries	2.98*	1.82*	3.44*
Electricity, gas and water supply	4.10*	3.61*	4.31*
Total manufacturing sector	3.02*	1.96*	2.63*
Gross value added (total manufacturing sector)	3.17*	1.91*	2.73*
MINING SECTOR	Gross value of output		
Coal and lignite	1.81*	1.47*	1.91*
Iron ore	5.16*	2.53*	4.31*
Mangsnese ore	(-)1.10	0.13	(-)0.50*
Copper	1.55	3.71*	2.42*
Gold	(-)2.19*	(-)1.51*	(-)1.81*
Limestone	7.75*	1.84*	3.66*
Mica	(-)1.69*	(-)2.72*	(-)2.09*
Other minor mines	5.12*	3.63*	5.65*
Total mining sector	1.72*	1.87*	2.30*
	Gross value added		
Coal and lignite	1.81*	1.47*	1.91*
Others	1.55*	2.35*	2.80*
Total mining sector	1.72*	1.81*	2.24*
	Net value added		
Coal and lignite	1.81*	1.40*	1.88*
Others	1.58*	2.34*	2.69*
Total mining sector	1.73*	1.76*	2.19*

* Statistical tests satisfied.

Table 2. Growth rates of indices of employment in the manufacturing and mining sectors

(Per cent per annum)

	1951/52 to 1959/60	1960/61 to 1975/76	1951/52 to 1975/76
MANUFACTURING SECTOR			
Food	1.28*	1.07*	1.20*
Beverages and tobacco	1.98*	(-)0.47*	0.06
Textiles	0.22	0.68*	0.46*
Leather and leather products, including footwear	1.34*	0.73*	1.44
Paper and paper products, including printing and publishing	1.58*	1.30*	1.58*
Wood and wood products, including furniture and fixtures	3.12*	1.13*	2.11*
Rubber and rubber products, including product for petroleum and coal	2.31*	2.47*	2.50*
Chemicals and chemical products	2.03*	2.40*	2.56*
Non-metallic mineral products	0.85	1.32*	1.64*
Basic metal industries	2.29*	2.36*	2.85*
Metal products except machinery and transport equipment	3.50*	1.00*	2.58*
Machinery except electrical machinery	2.99*	2.01*	3.06*
Electrical machinery	3.64*	3.20*	4.48*
Transport equipment	2.40*	(-)0.39	0.98*
Miscellaneous industries	0.75	(-)2.75*	(-)0.81
Electricity, gas and water supply	1.41*	1.12*	1.62*
Total manufacturing sector	1.24*	1.02*	1.29*
Coal and lignite	0.59*	0.34*	0.55*
Iron ore	3.70*	(-)0.17	1.23*
Manganese ore	0.72	(-)1.85*	(-)2.55*
Copper	1.12	3.01*	1.67*
Gold	(-)1.63*	(-)1.12*	(-)1.30*
Limestone	4.50*	(-)0.11	1.78*
Mica	(-)1.64*	(-)3.40*	(-)2.70*
Other minor mines	3.91*	1.38*	2.42*
Total mining sector	0.87*	0.16	0.38*

* Statistical tests satisfied.

Table 3. Growth rates of indices of labour productivity (1970/71 prices) in the mining and manufacturing sectors

(Per cent per annum)

	1951/52 to 1959/60	1960/61 to 1975/76	1951/52 to 1975/76
MANUFACTURING SECTOR	Net value added per employee		
Food	1.18*	(-)0.06	0.41*
Beverages and tobacco	1.08*	1.61*	2.22*
Textiles	1.07*	(-)0.05	0.31*
Leather and leather products, including footwear	0.41*	(-)3.78*	(-)1.81*
Wood and wood products, including furniture and fixtures	2.59*	(-)0.10	1.30*
Paper and paper products, including printing and publishing	1.71*	0.52*	1.10*
Rubber and rubber products, including products for petroleum and coal	4.70*	0.57	1.74*
Chemicals and chemical products	1.28*	0.99*	1.23*
Non-metallic mineral products	3.90*	0.67*	1.47*
Basic-metal industries	0.45	0.27	0.71*
Metal products except machinery and transport equipment	0.04	(-)0.49	(-)0.45*
Machinery except electrical machinery	5.30*	2.21*	3.49*
Transport equipment	3.60*	0.20	1.01*
Electrical machinery	3.42*	1.84*	1.48*
Miscellaneous industries	2.24	4.56*	4.25*
Electricity, gas and water supply	2.76*	2.50*	2.70*
Total manufacturing sector	1.77*	0.94*	1.34*
Gross value added (total manufacturing sector)	1.93*	0.89*	1.44*
MINING SECTOR	Gross value of output		
Coal and lignite	1.22*	1.13*	1.37*
Iron ore	1.46*	2.70*	3.08*
Manganese ore	(-)1.83	1.99*	2.04*
Copper	0.42	0.71	0.75*
Gold	0.56	(-)0.40	(-)0.52*
Limestone	3.24*	1.95*	1.88*
Mica	0.06	0.68*	0.61*
Other minor mines	1.22	2.26*	3.23*
Total mining sector	0.85*	1.71*	1.92*
	Gross value added		
Coal and lignite	1.21*	2.51*	1.99*
Others	(-)0.04	2.90*	4.11*
Total mining sector	0.77*	2.26*	2.68*
	Net value added		
Coal and lignite	1.21*	1.06*	1.34*
Others	0.26	2.52*	2.58*
Total mining sector	0.86*	1.61*	1.80*

* Statistical tests satisfied.

Table 4. Annual average growth rates of some selected indices (1961=100) relating to census and sample sectors of the Indian manufacturing sector (1960-1976)

	Census sector	Sample sector	Factory sector
Number of factories	5.2	4.6	4.6
Number of workers	3.2	3.0	3.0
Number of employees) other than workers)	8.7	7.2	8.2
Total number of employees	4.0	3.6	3.8
Net value added per employee at 1961/62 prices	2.04	(negligible)	1.84
Employment per employee at 1961 consumer prices	1.58	0.65	1.55

Table 5. Average growth rates of value added for employee in manufacturing sector from selected Indian States (1960/1961)

States	Census sector	Sample sector	Factory sector
Bihar	0.5	(-)0.9	0.5
Gujarat	2.3	(-)1.2	1.6
Maharashtra	2.4	2.3	2.6
Tamil Nadu	1.4	(-)0.1	1.2
Uttar Pradesh	2.5	(-)1.4	1.8
West Bengal	1.1	(negligible)	1.0
All India	2.0	(negligible)	1.8

Table 6. Growth rates of indices of capital input, total inputs, capital productivity and total productivity in the Indian manufacturing and mining sectors
(Per cent per annum)

	Manufacturing sector			Mining sector		
	1951/52 to 1975/76	1951/52 to 1959/60	1960/61 to 1975/76	1951/52 to 1975/76	1951/52 to 1959/60	1960/61 to 1975/76
Capital input	4.60*	6.00*	2.30*	3.10*	1.60*	2.40*
Total input	2.30*	2.20*	1.50*	1.20*	1.00*	0.90*
Capital productivity	(-)2.00*	(-)3.00*	(-)0.30*	(-)0.90	(negligible)	(-)0.60*
Total productivity	0.30*	0.80*	0.40*	1.00*	0.70*	0.80*

* Statistical tests satisfied.

Table 7. Sources of output growth in mining and manufacturing sectors, 1961-1975
(Percentage)

Source/period	1951-1956	1956-1961	1961-1966	1966-1971	1971-1975	1971-1975
Manufacturing sector						
Employment effect	38.33	40.99	57.99	27.31	93.60	35.62
Productivity effect	59.24	49.65	30.26	120.52	16.42	56.69
Effect of changes in the composition of employment	3.30	7.96	10.34	4.45	(-) 3.82	2.86
Interaction effect	(-) 0.87	1.40	1.42	(-)52.28	(-) 6.20	4.83
Mining sector						
Employment effect	80.87	15.12	10.14	(-)74.49	82.75	16.25
Productivity effect	64.96	60.79	74.56	140.74	18.12	60.18
Effects of changes in the composition of employment	(-)31.09	18.50	7.48	31.98	1.54	2.80
Interaction effect	(-)14.74	5.59	7.81	1.82	(-) 2.41	20.78

Annex

INDICES OF CAPITAL INPUT, TOTAL INPUT AND TOTAL PRODUCTIVITY
IN INDIAN MANUFACTURING AND MINING SECTORS
(base 1970/71 = 100)

Year	MANUFACTURING SECTOR				MINING SECTOR			
	Capital input	Total input	Capital productivity	Total productivity	Capital input	Total input	Capital productivity	Total productivity
1951/52	9.91	35.08	308.38	87.12	30.29	63.64	133.44	63.51
1952/53	11.83	37.00	257.73	82.41	31.25	64.98	136.29	64.00
1953/54	12.66	36.36	252.37	87.87	32.00	67.79	131.97	62.30
1954/55	13.98	37.58	254.15	94.54	32.84	66.46	133.92	66.18
1955/56	15.80	39.27	251.52	101.20	33.50	68.84	134.30	65.35
1956/57	18.39	43.55	238.61	100.76	35.40	73.15	134.44	65.06
1957/58	22.72	46.84	200.18	97.10	37.68	76.20	134.98	66.75
1958/59	26.31	47.98	175.52	96.25	38.83	76.48	134.38	68.28
1959/60	29.87	52.00	169.00	97.08	41.05	74.43	134.88	74.39
1960/61	35.86	56.26	156.11	99.50	52.59	82.26	120.52	77.05
1961/62	43.60	61.71	141.65	100.08	56.11	95.44	119.73	78.63
1962/63	61.58	72.19	110.05	93.88	68.40	91.52	111.02	82.62
1963/64	63.58	75.86	116.10	98.98	77.73	97.19	98.89	79.09
1964/65	72.10	82.62	113.41	98.97	81.53	97.13	95.96	80.55
1965/66	77.36	86.37	108.88	97.55	93.70	102.48	94.59	86.49
1966/67	84.57	89.57	101.11	95.47	91.36	102.25	100.16	89.50
1967/68	92.43	93.90	93.63	92.16	93.11	100.33	101.63	94.32
1968/69	103.75	99.00	90.36	94.71	99.13	100.21	97.10	96.06
1969/70	99.46	97.72	96.57	102.53	104.21	101.71	96.79	99.16
1970/71	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1971/72	102.14	100.20	99.97	101.91	101.72	99.98	100.76	102.51
1972/73	104.99	104.25	101.48	102.20	101.87	102.69	104.97	104.13
1973/74	98.66	102.86	113.03	108.40	125.23	118.89	83.59	90.16
1974/75	82.86	97.01	139.22	118.92	129.44	121.94	90.50	96.07
1975/76	89.04	101.12	130.73	115.11	142.94	129.31	90.57	100.21

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